

From Rites to Rights: the Co-evolution of Political, Economic and Social Structures

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Abstract

It is the charge of economic history not only to explain the economic past, but to use it to enrich and develop economic theory (North, 1994). In paleoeconomics, theory plays the additional role of adding veracity of accounts based on sparse evidence through the demonstration of internal consistency. We synthesize pre-historical and historical evidence available from the settlement and modernization of the Hawaiian economy into a stylized picture of the co-evolution of production and governance structures called the *governmental Kuznets curve*. We explain the co-evolution with a theory of institutional change that includes the roles of resource scarcity and opportunities for internal and external economies of scale in the increasing intensification and specialization of production. These are facilitated first by a steeper and then by a flatter political organization.

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1. Introduction

In the beginning of his Nobel lecture, Douglass North opined that "The object of the field [of economic history] is not only to shed new light on the economic past, but also to contribute to economic theory by providing an analytical framework that will enable us to understand economic change." In paleoeconomics, the roles of theory and evidence may appear even more indeterminate. Not only can sparse evidence provide stylized facts that result in theory that applies both to the case in question and elsewhere, but theory may help to provide an account of what happened that is internally consistent as well as being consistent with the sparse evidence. To this end, we attempt herein to illuminate both the nature and causes of growth and institutional change by using both archeological and historical evidence from the settlement and modernization of the Hawaiian economy to develop a candidate theory of the natural co-evolution of production systems, organizational forms and authority structures.

We focus our search by summarizing the physical evidence brought forward by Kirch and his interdisciplinary team of researchers on Hawaiian pre-history. As we do, these researchers choose Hawaii because

“the archipelago... presents an ideal region for understanding complex interactions between human populations and their environments. In Hawaii such interactions can be tracked over a time frame of about 1200 years. During this period between the discovery and colonization of the archipelago by humans and the arrival of Europeans, archaeological research reveals the emergence of a highly complex island civilization which by A.D. 1700 had approached the level of an “archaic state.” In Hawaii, historical anthropologists and natural scientists have the opportunity to study the emergence of such complexity in the context of dynamic coupling with natural systems.” (Kirch, 2007)

We present sparse evidence in support of stylized facts about Hawaiian economic development, and expand the discussion into the historic era, where Hawaiian economic development shifts rapidly, though not uniformly, from hierarchical control to decentralized decision-making.

2. Archeological and Historical Record

Over Hawaiian history, social organization went from family to hierarchy to more complex and larger hierarchy (vertical and horizontal expansion) to private. Transitions were gradual, e.g. with some private property coexisting with hierarchies. Even the great Mahele, often historically billed as a quick transformation in 1848 from hierarchy to private property, took many years to settle, and was incomplete, i.e. it left much land and marine resources as common property.

The standard division in Hawaiian history between the pre-historic record (until Western Contact in 1778) and the historic record masks the underlying pressures affecting the rapid institutional change that occurred following Western Contact. We divide the timeline with a slight distinction, first focusing on the evolution from the colonization of the islands to the monarchy and then investigating the switch to decentralized decision-making that evolved over the course of the 19th Century. This distinction helps drive the theory of institutional adaptation and its co-evolution with economic development as a function of the underlying economic pressures presented by factors that include resource use (intensification, capital formation, and abandonment) and relative price shifts from changes in supply and demand.

The co-evolution of governance and property with respect to resource scarcity can be clearly illustrated by considering these two distinct periods in Hawaiian history. The first period is further divided into sub-periods wherein property structures, governance, and scarcity pressures changed. The first period, encompassing all of Hawaii's pre-history, is divided by anthropologists into 4 eras: (1) Colonization, (2) Developmental, (3) Expansion, and (4) Proto-historic, which we link to their corresponding economic interpretations: extensive growth, intensive growth, and capitalization, and add (5) Unification, and (6) Independent kingdom, during which new opportunities for trade are introduced under an intensifying system of hierarchical control of a diminishing native population. The second period consists of the decline of the kingdom and the evolution to decentralization as a U.S. territory/state, categorized by increasing opportunities for trade and marked by differences in decentralization of common property resources as a function of their value.

2.1. Co-evolution of Specialization and Hierarchy before Private Property

Figure 1 summarizes available archeological and proto-historic evidence on the timing of Hawaiian cultural development until just after Western Contact. We reclassify these stylized anthropological periods for Hawaii (Kirch, 1985) until unification under Kamehameha I (the inception of the monarchy) to depict stages of economic growth. During this time, the institutional framework evolved from family networks to an intensive hierarchy though the overall *ahupua'a* and *kapu* systems operations maintained a defining continuity.¹ These systems of production and enforcement could be, and were, intensified or relaxed, within limits, to accommodate population growth and capital formation.

¹ See appendix 1 in Kaiser and Roumasset 2007

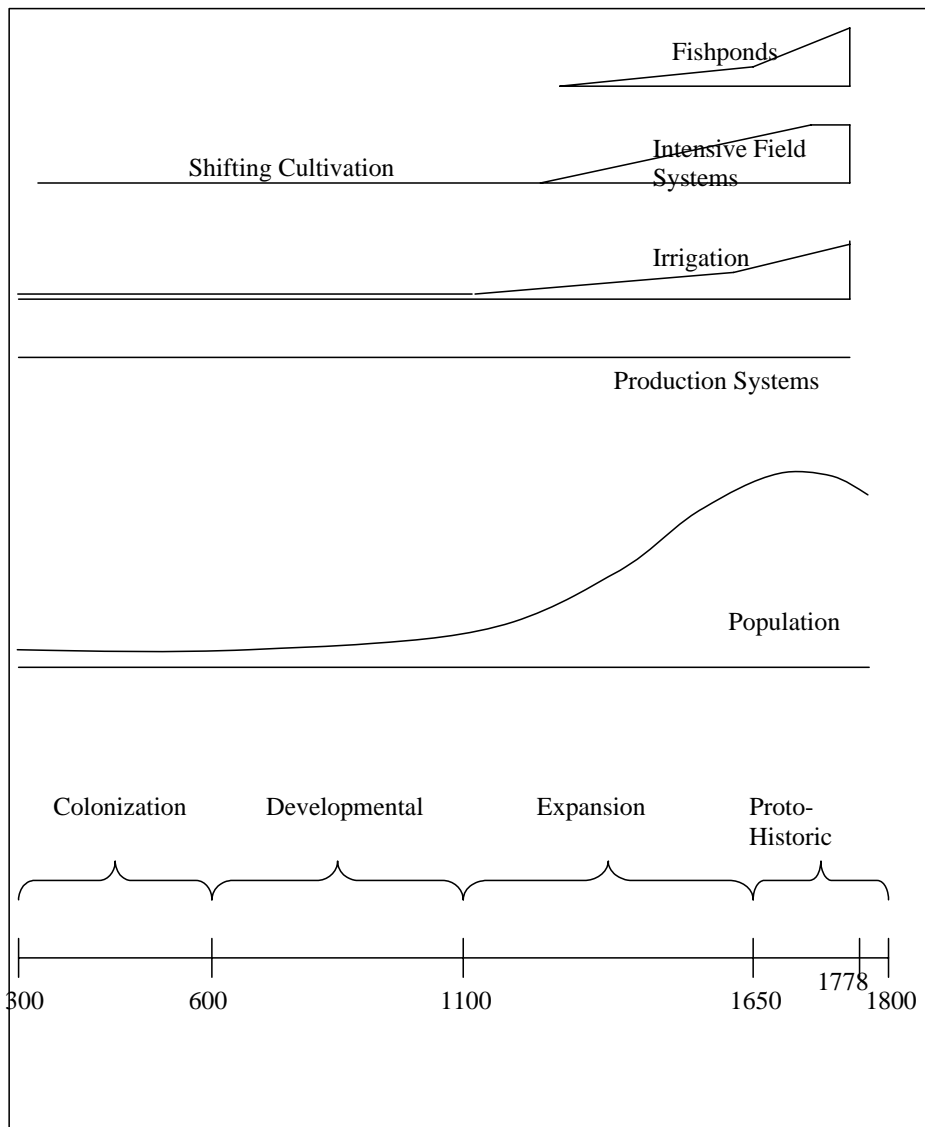


Figure 1: Timeline for Hawaiian resource use and development
(Adapted from Kirch (1985), p. 300-1)

Colonization and development are combined as a period of extensive growth as Polynesians arrive and sparsely settle coastal areas, moving slowly upland. Populations may have been very small, perhaps 100 people in an extended *‘ohana* (Kirch, 1996). Governance for some time after the Polynesians arrived in Hawaii (roughly 400 A.D.) developed under an *‘ohana* (community management) system wherein the patriarchs of each extended family determined production and enforcement. Extremely low populations, the introduction of new agricultural products (e.g., pigs, taro), and the slow subsequent transformation of the most fertile

valleys (wet, windward areas), adjacent to superior fishing grounds, grew into populated communities. Marine and terrestrial resource pressures were low,² and though societal institutions to govern resource scarcity, particularly the *kapu* (taboo) system, had traveled to Hawaii with the earliest Polynesian settlements, implementation and enforcement were low (Kirch, 1996).

From these beginnings, we see continuous evidence of increasing intensification of production both on land and at sea. Technology becomes standardized, evidence of intermediate goods produced by a rising class of specialized adz-makers and fishhook producers (Kirch, 1985, p. 184).

As populations grew and became more permanent in the Developmental era and into the expansion era, governance by family eventually extended to governance of the entire *ahupua'a* valley, under a single chief or *ali'i*. During the Expansion Period (1100-1650) population estimates increase to several hundred thousand, with some estimates as high as 800,000 (Kirch, 1985; Kame'eleihiwa, 1992). The acceleration of population growth, particularly from 1200-1650, was followed by the intensification of food production, including capitalization. Soil analyses of dryland agriculture indicate that virtually all arable lands were brought under cultivation (Kirch et al, 2004). The chief allocated land and labor within a valley to their uses and began to take advantage of the top-down power to achieve economies of scale and increased production intensity through specialization, eventually building large-scale irrigation projects and fish ponds in particular. Governance also accelerated, particularly at the end of the period. The archaeological record shows increased temple-building, consolidated control, and expansion of territory on both Maui and Hawaii from 1570-1630 (Kirch, 2005).

Other indications of intensified governance come from fish pond management. Strict limited access to the ponds controlled rent dissipation, and governance measures increased accordingly.³ With little trading between *ahupua'a*, and the ability of the *ali'i* to reserve the

² It is clear from bone pile analyses that pig and dog populations were growing rapidly over the time period and increasingly supplementing the fish protein collected from the sea, and resources were increasing as transplanted food species took hold in the new environment.

³ Only 30% of *ahupua'a* had associated fishponds (ponds never crossed *ahupua'a* borders), and the ponds' total area of about 6650 acres would have produced somewhere between 1.75 million and 2 million pounds of fish per year – about 6 to 9 pounds per person per annum at the time of contact (Kikuchi, 1985; Hammon, 1975). Population in the islands has been conservatively estimated at 200,000-225,000 in 1778, at contact.

catch for themselves, fishponds produced considerably greater sustenance for the higher levels of the social hierarchy with little direct benefit to the commoners, though indirect benefits stemmed both from reduced fishing pressure on the coastal fisheries and from the increased fish population overall.

The hierarchical *ahupua'a* system allowed the capture of the economies of scale necessary to develop these fishponds while the complementary *kapu* system provided the mechanism by which efficient harvesting could be enforced. Inasmuch as the *ali'i* captured the rents, this exemplifies a case in which the *primary action group* (Davis and North) undertakes the institutional innovation in question.

This system of control evolved into an extensive hierarchy during the Expansion era and eventually crystallized during the proto-historic period (1650-1785), at the height of the islands' population, exhibiting a much higher degree of social hierarchy, specialization, and governance structure than in other parts of Polynesia (Abbott, 1992; Handy and Handy, 1991).

Within this growing hierarchy, decision-making and authoritative duties begin to be addressed by different parties acting for the chiefs. "Low-level" *konohiki* resource managers⁴ develop increasingly sophisticated irrigation⁵ and communal fishing techniques, and fishponds are developed and evolve into true aquaculture,⁶ a unique Hawaiian development amongst Polynesian cultures, to increase productivity. Kinship networks give way to specialized skills in fishing and farming, managed by the *konohiki*. Without external trade, hierarchical stratification increases, as do efforts at resource extraction for the benefit of the *ali'i*. The commoners produce for the *konohiki*, who controlled the water supply, determined the land allocations for the commoners, determined fishing rights, and allocated *ahupua'a* resources for production, especially labor for communal projects. The *konohiki's* duty to the *ali'i* was to meet an expected production goal to be presented during the *makahiki* festival, at which time the *ali'i* divided the tribute amongst his supporters in the chiefly class, including the *konohiki*. Increased governance came from the parallel development of a large priesthood and increasing use of the *kapu* to

⁴ For illustration of Hawaiian hierarchy, see Kaiser and Roumasset 2007

⁵ In particular, increased use of Type III irrigation systems, consisting of an irrigation canal running along the periphery of the field complex, allowing more sophisticated control of water distribution than was used in earlier Type II systems, where small groups of fields were watered by a single ditch that fed directly into the uppermost field.

⁶ True aquaculture means that fish are bred and nourished in captivity; other Polynesian fishponds were holding pens fed by ocean tides.

restrict resource use and population. This mechanism supported an increasingly stratified society.

This stratification appears to have steepened more rapidly on marginal lands than on lands that produced large surpluses easily (Kirch et al., 2004, Vitousek et al, 2004). Without additional trade opportunities to increase economic growth, the proto-historic period also experiences increased warfare over increasingly scarce resources, mainly initiated by chiefs controlling these marginal lands. Appendix 2 summarizes in table form (see Kaiser and Roumasset 2007).

Hierarchy lingered past Western contact and its institutions for private property, culminating in the Hawaiian kingdom formed under Kamehameha I in 1805. Most local resources experienced dramatic changes in value and governance needs after western contact, however. While rent extraction by the Hawaiian chiefs was expected and accepted as the way of life, the hierarchical authority included a mechanism for transferring these rents every generation in order to maintain consolidated support for the *ali'i nui*, or head chief. This mechanism, the *mahele*, was a redistribution of rights from top to bottom that occurred with every change of leadership. With consolidation into the Hawaiian kingdom under King Kamehameha I after western contact, rent extraction opportunities increased rapidly. Kamehameha I, however, was a conservationist, and under his reign, three major fishpond projects were undertaken, and sandalwood trading with Westerners was carefully managed.

Enforcement costs of the consolidated hierarchy increased under his successor, Liholiho. Unable to bring about a *mahele*, the chiefs gained power to extract greater rents of their own, with greater competitive pressures among them, and sandalwood resources quickly dwindled (LaCroix and Roumasset I). The introduction of new religious institutions (Christianity in particular) and the apparent impotence of the Hawaiian gods in protecting the population from Western diseases rendered the *kapu* system less effective and the system was officially abandoned in 1819. (Kame'eleihiwa, 1992, p 140ff). Sandalwood was depleted by 1850, leaving not only a void in tradable goods, but also considerable environmental degradation to watersheds. Thus the greater scarcity of extractable resources increased the benefits of conservation just as the hierarchical institution designed to protect them failed due to the increased costs of governance

The subsequent transition to private property, frequently portrayed as an overnight coup defined as the Great *Mahele* of 1848, was neither instantaneous nor complete. Neither fully-formed fences nor production and enforcement systems materialized overnight, though the relative cost of moving to private property, despite the large initial fixed costs of the Great *Mahele* and in establishing a series of constitutions, had become efficient. The scope and breadth of central government authority increased; these constitutions established a cabinet, a civil service, and an independent judiciary by 1847. Through this expensive investment government lowered per-unit costs of providing governance and ensured a higher level would be provided. At the same time, the move lowered informational costs by enabling decentralized decision-making through private property.

The native population decreased, perhaps by 90% in a generation, rapidly deflating the pressures that drove specialization, intensification, and the growth of governance before Western contact. New products were introduced driving fundamental economic shifts and reducing the effectiveness of *ahupua'a* management in meeting society's needs. The *kapu* governance system was soon in tatters, raising the enforcement costs of hierarchy.

The population decline after Western contact was not accompanied by a direct reduction in resource pressures, however. Resource pressure from population growth alone is therefore insufficient to explain increases in governance and intensification. Instead, relative prices for resources began to shift; for example, with respect to marine resources, benefits from coastal fisheries for local demands were reduced while benefits from ocean fisheries for trade expanded. Institutions shifted accordingly, and governance efforts did not abate, as the new judicial system and placed control over public goods, particularly education, in the hands of a representative legislature (Daws, 1974, p. 107), which over time imposed more stringent rights and governance on the increasingly valuable ocean fisheries and a return to less stringent and more local enforcement in less valuable coastal fisheries.

As a less costly governance mechanism available within the existing Hawaiian institutions, the *konohiki* maintained governance rights over these less valuable coastal, common-property fisheries. Private decision-making within the new property rights system for fisheries continued to balance enforcement costs against benefits as well. *Konohiki* sought to incur the costs of fishery registration when the asset was more valuable, leaving less valuable

assets to open access. Enforcement declined across all coastal fisheries as the resource value decreased over time.

Opportunities for exchange also promote specialization and intensification by increasing the value of the resource base. As the consumption set expands to include gains from trade and as the number of potential transactions expands, centralization of decisions will face increased costs as the informational burden increases. Efficiency is likely to give way to rent-seeking. Centralization of authority, however, should increase in order to meet increased governance requirements. These governance costs will include the high fixed costs of transitioning to a rule of law and establishing rights to property.

2.2. Stylized Facts and Synthesis

We can conveniently summarize from this archaeological and historical record, the stylized facts before and after Western contact.

Before contact: The increase in population before Western contact was associated with increasing horizontal specialization and intensification of agricultural production and resource use. Both the control and decision-making aspects of governance became more centralized. Social hierarchies were closely aligned with increasingly vertically specialized managerial structures. Specialization was primarily within ahupua'a hierarchies not across hierarchies.

After contact: Slightly before Western contact, and increasingly after contact, population declined, but intensification and specialization continued due to the opportunities afforded by international trade. Private property developed and decision-making became decentralized. Specialization across hierarchies developed along with trade.

Figure 2 illustrates these stylized facts. As private property expands, governance costs and government responsibility increase. Private property does not obviate the need for government intervention. As decision-making is decentralized, growth and development require institutional support for voluntary contractual exchange as well as for resolving externalities and public good problems imposed by the conflicting goals of individual decision-makers. At low levels of scarcity and specialization, centralization of authority and decisions increase together, to reduce idiosyncratic risks through mutual insurance and diversification, and exploit economies

of scale in production, e.g. large scale irrigation works. The goal of the theoretical development to follow is to explain these patterns.

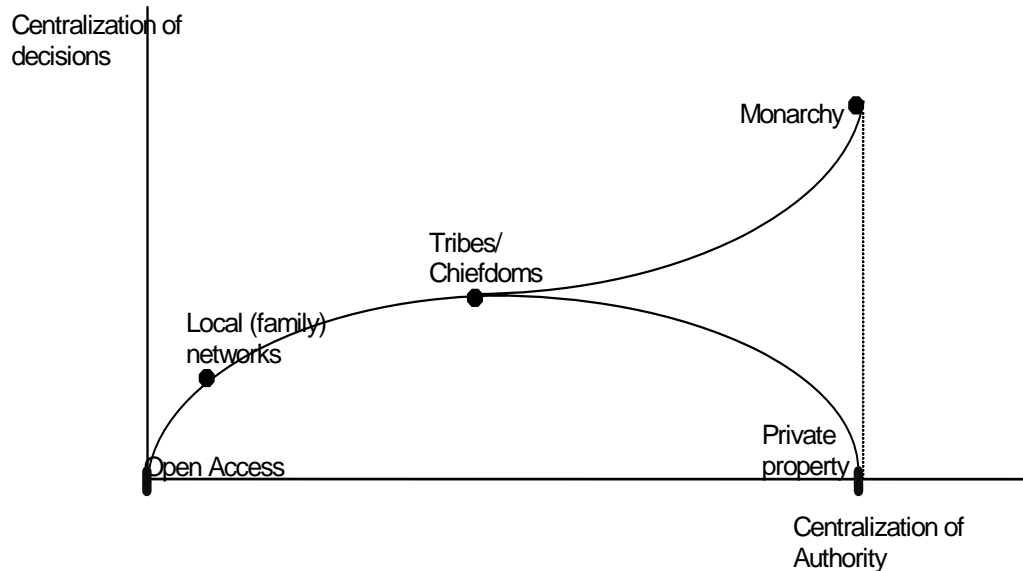


Figure 2: The Governmental Kuznets Curve

As resource pressures increase, returns to specialization, intensification, capitalization and governance require additional centralization of authority and decision-making, which can be developed in small populations, with limited opportunities for external economies of trade, through hierarchy. With larger populations or a change in opportunities for trade, hierarchy's relative inability to solve information problems may lead to institutional changes favoring decentralization of decision-making while increasing centralization of authority in the form of property rights.

At this point, the existing second-best theory suggests that institutions will change whenever the net benefits to doing so are positive. In particular, institutions that manage resources through common property, public property, or private property are perceived as comparable solutions to the open access problem, and comparing these institutions according to the extended Demsetz theory involves weighing known enforcement costs against the benefits that a particular institution delivers by reducing free-riding.

3. Dynamic Theory of Resource Use and Institutional Change

3.1. A Resource Capital Theoretical Base

The evolution of property has been at the heart of the New Institutional Economics since its inception. However, the theory is incomplete regarding the nature of agency costs and the lack of capital-theoretic foundations. We hypothesize that property coevolves with governance, which increases with the intensification and specialization of production; increasing scarcity of land and marine resources leads to more and broader governance and greater resource use restrictions, if enforcement mechanisms are also free to evolve. By drawing on the relatively short time span between settlement and modernization of the Hawaiian economy, we clarify at least one plausible mechanism for this co-evolution. As Hawaii moved from a Neolithic group of small isolated villages to a unified kingdom and finally to U.S. territorial status and eventual statehood, old and new institutions, some of which were imposed, overlapped. The experience provides an intriguing opportunity to study the natural co-evolution of decision and authority structures as resource scarcity, productivity, and trade increase, population fluctuates, production intensifies, and economic growth is characterized by both vertical and horizontal specialization.

In the Coasean paradigm, first-best efficiency, whether achieved through decentralized, centralized, or intermediate institutions, is only a point of departure for comparative institutional analysis. What is needed is a conceptual framework capable of generating propositions and explanations regarding which institution is second-best efficient under what circumstances.⁷ The advocates of private property (Demsetz), public property (Hardin), and communitarianism (Ostrom) all implicitly agree that the relative efficacy of these institutions rests primarily on their ability to control the free-rider problem.

Field (1989) extends Demsetz's theory of institutional change in a useful but incomplete fashion. Field begins by noting that economic organization and growth of non-industrial economies can be classified into three stages. In the first stage, production is organized by families or small groups of families. In the second stage, these groups are consolidated into larger communal units. In the third stage, production devolves to family farms or other small production units, facilitated by private property. Accordingly, the evolution of property can be

⁷ This use of second-best follows Dixit (1996). He subsumes rent-seeking, corruption, and other elements of political economy in his theory of the 3rd-best.

indexed by the number of commons. Complete decentralization under private property is achieved when the number of commons equals the number of firms (or families).

The theory is still incomplete, however, in a number of respects. The primary problem is that each institution is implicitly associated with a fixed value of benefits and costs. This is not Field's unique problem but the problem with the theory of institutional change generally.⁸ Consider the marginal benefits of dividing the resource among more groups, each of which is responsible for its management. The proposition is that the costs of rent dissipation will go down with increased division. Field properly includes the costs of group contracting in with the costs of rent dissipation. The idea is that group contracting costs will go down in aggregate because of Olson's Law⁹ and that rent-dissipation will go down because there is more accountability with smaller groups and the free rider problem will be better contained. But an optimization problem has been suppressed in this reasoning. For the group to manage its resources efficiently it will invest in group contracting and management until the marginal costs of so doing are equal to the marginal reduction in the value of rent dissipation that is achieved thereby.

Similarly, "exclusion costs" are at best a reduced form function of the number of commons. The suppressed optimization problem involves increasing exclusion expenditures until marginal value of reduced theft etc. equals marginal cost thereof. In section 4, we attempt to make these tradeoffs more transparent by exploiting the key insight of Jensen and Meckling (1976) that agency costs and residual departures from first-best efficiency are jointly determined. In addition, the potential economies of scale and opportunities for specialization need to be incorporated in assessing that tradeoff. Finally, inasmuch as the evolution of economic organization is fundamentally dynamic, the theory must rest on capital-theoretic foundations.

Inasmuch as government has a comparative advantage in some information and enforcement activities, we can extend these total system costs to include those of constitutional governance, e.g. defining and enforcing property rights (Libecap, 1978). In McChesney's (2002) consideration of the famous cattle-trampling of crops, enforcement is not limited to fencing but includes monitoring and enforcement activities by the state. In the efficient solution, governments and private actors each perform those information/enforcement activities in which

⁸ Conventional theories treat different institutions as discreet entities. Field and Anderson-Hill (1975) implicitly index different institutions by a continuous variable.

⁹ Mancur Olson, *The Logic of Collective Action* (Cambridge: Harvard University Press, 1965).

they have a comparative advantage, much as the Coasean firm chooses to coordinate some production itself and subcontracts other production to outside suppliers. In this view property can arise through private enforcement efforts (e.g. Demsetz's (1967) Native American beaver trappers and Anderson-Hill's (1975) fencing farmers) or through Libecap's (1978) property-defining government.

One significant conceptual weakness of property rights theory is its overall lack of capital theoretic foundations. As an asset's value increases, it is natural to expect that investments in protecting or enhancing its value will increase over time. Anderson and Hill (1990) have provided a dynamic theory of a one-time investment in enforcement costs, e.g. building a fence, but have not considered the possibility of increasing governance-capital over time.

Even the extended theories of Anderson and Hill (1990) and Lueck (2002) are incomplete, however. First, they analyze only the steady-state institutional costs, wherein rents are fully dissipated under open access, fully captured under private property, and common property regimes lead to resource exploitation that lies between these steady states. Further, both implicitly assume that the enforcement costs of a particular institution are clearly defined. This in turn suppresses the problem of determining, for a particular organizational form, how much and what form of governance is optimal. For the case of common property management, for example, the community must determine the rights and responsibilities of members, and choose an incentive structure as well as its technology of enforcement. Until this governance structure is specified, neither the benefits nor costs can be determined.

In what follows, we exploit resource economics in a more generalized and dynamic setting to provide a theory that encompasses the full spectrum of Hawaiian economic development.

Suppose that a resource stock at time t is $s(t)$ is extracted at rate $x(t)$ at a cost of $c(s(t))$ per unit to obtain benefits (consumer surplus). Assume that $P(z)$ is the inverse demand function or price of the resource. The cost of extraction is assumed to be a decreasing function of its own stock, $c'(s) \leq 0$. The stock increases with natural growth, $F(s(t))$, and decreases with harvest, $x(t)$.

The natural growth function, $F(s)$, is assumed to have the traditional properties; strictly concave and attains a maximum at a finite value of s . Over time, the rate of change in stock is then,

$\dot{s}_t = F(s_t) - x_t$. Given discount rate r , a hypothetical social planner chooses the resource extraction path, $x(t)$, to maximize the present value of net social welfare, which includes the consumer surplus from resource consumption minus the cost of extraction, i.e.,

$$\max_{x_t} V = \int_{t=0}^{\infty} e^{-rt} \left[\int_0^{x_t} P(z) dz - c(s_t)x_t \right] dt$$

$$s.t. \quad \dot{s}_t = F(s_t) - x_t$$

The corresponding current-value Hamiltonian is:

$$H = \int_0^{x_t} P(z) dz - c(s_t)x_t + \lambda_t [F(s_t) - x_t]$$

where λ_t is the shadow price of the resource (which is equal to the marginal user cost). The first-order conditions are:

$$\frac{\partial H}{\partial x_t} = P(x_t) - c(s_t) - \lambda_t = 0 \quad ; \text{for all } t$$

$$\frac{\partial H}{\partial s_t} = -c'(s_t)x_t + \lambda_t F'(s_t) = r\lambda_t - \dot{\lambda}_t \quad ; \text{for all } t$$

Rearranging the first-order conditions, we obtain an expression for resource royalty:

$$P(x_t) - c(s_t) = \lambda_t$$

Solving the first-order conditions together:

$$P_t = c_t + \frac{\dot{P}_t - c'(s_t)F(s_t)}{r - F'(s_t)} \quad (1.1)$$

where P is the resource price, and the RHS represents the marginal opportunity cost (MOC), composed of c , its marginal extraction cost (MXC), and the marginal user cost evaluated at the end of the period (MUC);¹⁰

Since the right-hand side of (1.1) is the marginal opportunity cost, (1.1) states that optimal resource extraction is achieved when the marginal benefit (price) of resource use equals the marginal opportunity cost.¹¹ Equation 1.1 implicitly defines both the optimal stock (S^*) and the optimal extraction (x^*), at any point in time.

For clarity and generality, we do not illustrate the possible dynamic paths that optimal resource use takes over time here (see e.g. Clark, 1990, for visual representation), nor do we model the human population growth or labor decision as integral to the use of the resource stock; unlike the Brander-Taylor (1998) model we do not assume that the population is dependent on this resource for survival and thus we assume a more broadly applicable, exogenous demand curve that easily reflects changes in relative prices for alternative goods. This also allows us to avoid limiting our analysis by choice of functional form. Rather we describe the static first and second-best outcomes at different points in time to emphasize the shift in resources to compensate for the move to the second-best outcome.

Figure 3 illustrates the static efficiency possibilities for optimal and second-best outcomes for resource use. Panel A of Figure 2 illustrates the standard first-best optimal resource extraction x^* , where $MB = MOC_1$, in contrast to open access extraction (x_{OA}) which occurs where marginal benefit equals marginal extraction cost for a single time period. Note, however, that if the resource is plentiful enough so that MOC intersects MB at X_{OA} , i.e. $MUC = 0$, then open access (X_{OA}) is first-best efficient.¹² If the resource is even more abundant, then equilibrium extraction can be less than socially optimal. While this possibility was appreciated in the past (Huxley, 1881; Taylor, 1951), it has been overlooked or even denied in

¹⁰ Strictly speaking, marginal user cost is defined as the reduction in the present value of the stock from extracting an additional unit (Dorfman, 1969). By convention, however, MUC in resource economics is typically evaluated at the end of one period so that it is commensurate with royalty. That is, the second term on the RHS of 1.1 is the Dorfman marginal-user-cost times one plus the real rate of interest.

¹¹ See e.g. Pearce and Turner (1990).

¹² It is not impossible that $MUC < 0$, in which case open access actually wastes economic opportunities with under-harvesting of the resource as this subsidy from the future gains to today's harvest is not realized.

the literature since Gordon's (1954) portrayal of the fishery dismissed it. We resurrect it here as an important component of continuous institutional development, explored below.

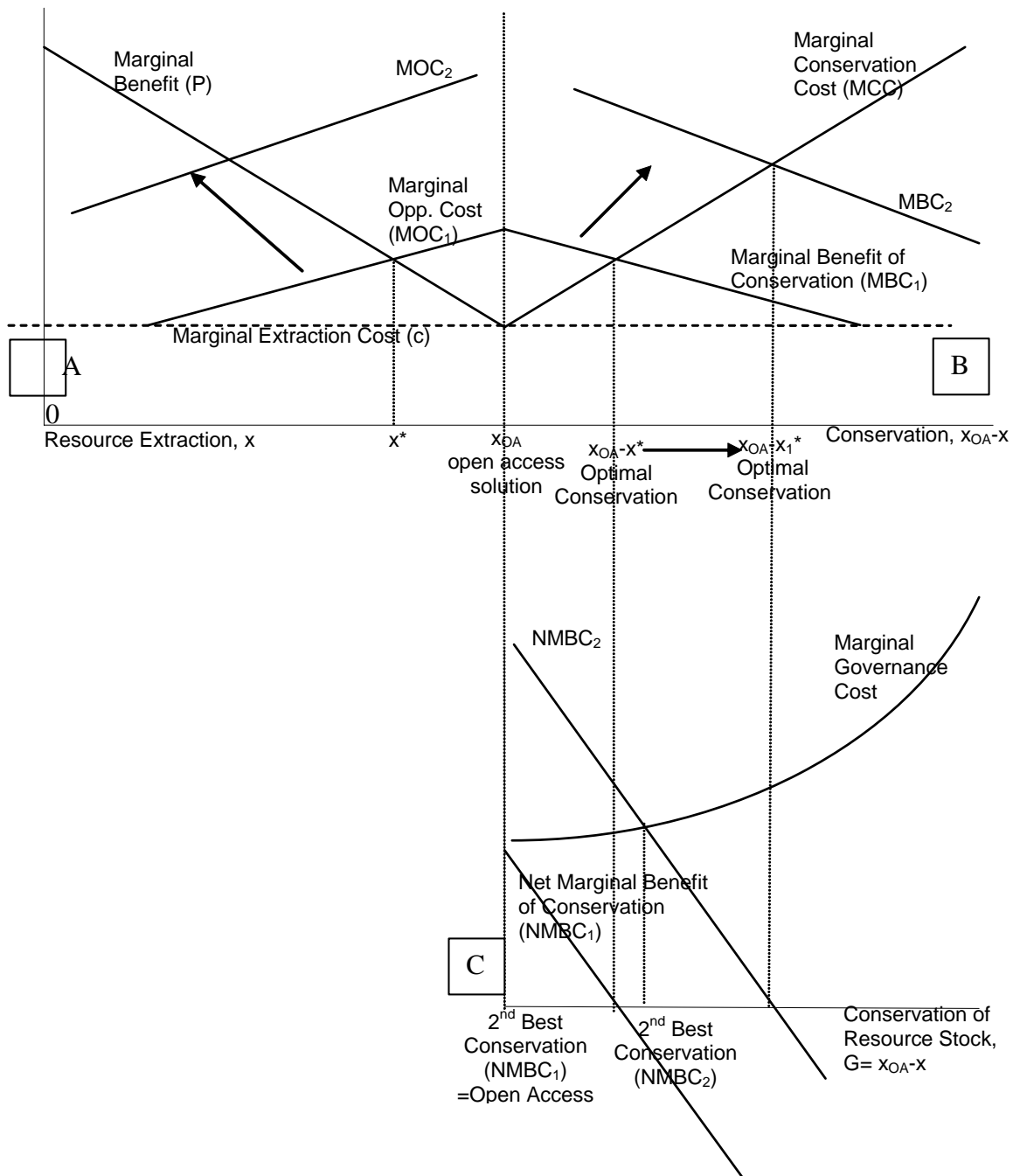


Figure 3: A second-best theory of resource management (common property or otherwise): comparative statics

In Panel A, we see that as MOC increases to MOC_2 , either through increasing extraction costs or increasing scarcity, the optimal amount of resource extraction should decrease. If, on

the other hand, demand were to increase (not shown), the optimal amount of resource extraction should increase. With both shifts occurring simultaneously, the net effect on extraction will depend on the relative size of the shifts.

Panel B reflects these curves' mirror images to show clearly the marginal benefits (MBC_1) and marginal costs (MCC) of conservation of the resource in the form of reduced extraction, so that first-best optimal conservation is $x_{OA} - x^*$, where the marginal benefit of conservation equals its marginal cost. Notice again that only if $MUC'=0$ can open access provide the first-best level of conservation. The increase in MOC from Panel A translates to an increase in MBC from MBC_1 to MBC_2 , indicating an increase in the optimal level of conservation. Similarly, an increase in MB will reduce the Marginal Conservation Cost. However, the reduction in MCC does not translate to a reduction in optimal conservation, since the Marginal Opportunity Costs are increasing in extraction, and the open access level of harvesting is greater with higher demand, the conservation effort under a higher level of demand will be larger since units of the resource that had no value at lower price levels now generate marginal benefits from conservation.

Now recognizing enforcement (e.g. building fences, catching violators) and other costs of *administering* conservation, we can see that second-best optimal enforcement is generally less than that of the first-best solution. There remains ambiguity in these administrative costs. For now, one can think of the Marginal Governance Costs (MGC) as being either "short run," i.e. within a specific institutional framework, or "long run," i.e. the optimized governance structures including institutional change.

The form of these governance costs is here assumed to be increasing in the resource stock. This fits with the existing literature; it also highlights the limited dimensionality of the existing literature. As Allen (2002) and others have tried to explore these almost amorphous governance costs within the Coase-Demsetz framework, they have focused on one portion or another of a broad definition of transactions costs to fit a particular case. This broad definition can be divided into two camps, the "neoclassical" camp, where transaction costs are costs of exchange, and the "property rights" camp, where transactions costs are all costs of establishing and enforcing property rights (Allen, 1998).

Using the property rights definition, anything that is inefficient is a transaction cost, and this “deus ex machina” approach is more convenient than it is informative. We seek to make the components of our governance costs explicit, including transaction, agency, and enforcement costs. Thus, we first define governance costs $G(S)$, a function of conservation, S , as constitutional agency costs, including the actual resources used up in the enforcement and organizational effort plus the shirking costs that remain.¹³ We elaborate further below, but it is instructive now, using this generic definition that is free from institutional form, to examine the impact of resource stock pressures on governance.

Now, we incorporate enforcement (e.g. building fences, catching violators) and other costs of *administering* conservation into the problem. Let x_{OA} represent the open-access extraction rate (where $P=c$). The level of conservation, thus, can be represented by the difference between open-access extraction (no conservation) and real extraction, i.e. $x_{OA}-x$. We assume that the governance cost, G , is an increasing function of conservation $G'(x_{OA}-x) > 0$. In other words, the marginal governance cost (MGC) is positive. G is assumed to be a stable function of conservation, i.e. even though the marginal benefits of conservation change over time, the cost function does not. Recognizing governance cost, the resource optimization problem can be written as:

$$\max_{x_t} V = \int_{t=0}^{\infty} e^{-rt} \left[\int_0^{x_t} P(z) dz - c(s_t)x_t - G(x_{OA} - x_t) \right] dt$$

$$s.t. \quad \dot{s}_t = F(s_t) - x_t$$

Setting up the Hamiltonian and solving the first-order conditions as in 1.1, we have:

$$MGC_t = \frac{\dot{P}_t - c'(s_t)F(s_t) + M\dot{G}C_t}{r - F'(s_t)} - (P_t - c_t) \quad (1.2)$$

¹³ For the special case where the organization is a firm, governance costs are agency costs (Jensen and Meckling, 1976; Roumasset, 1995).

Panel C shows the net marginal benefits of conservation ($NMBC_1$) and introduces the governance costs (MGC), which are assumed to increase with the level of conservation. The net marginal benefit of conservation (MBC-MCC) is the marginal benefit of controlling resource use. The optimum governance of resource extraction occurs where this marginal benefit equals the marginal cost of governance whether it be through socialism, capitalism, or communitarianism. Notice that in this case, open access may be second best optimal, and it is not necessary for $MUC'=0$ to achieve this result.

This provides a suggested framework for integrating resource management and governance, under which we can show that open access can be second-best optimal. Finally, we demonstrate that the effect of increasing demand and/or resource depletion is an increase in optimal governance.

The structure provided in equation 1.2 can be used to explain the co-evolution of governance and natural resource management. As the curves shift to reflect population pressures and resource availability, the second-best optimal solution may change. The shift presented in Figure 3 corresponds to an increase in resource pressures over time leading to increased conservation. When the population is low and resources abundant, so that MUC is small and MGC is large compared to the NMBC at the 1st best optimal level of conservation, little or no governance costs are warranted. Indeed if resource use is sufficiently low, open access may be 2nd-best optimal, as shown in panel C of Figure 3.

3.2. Governance

Governance, within any institution, is the mechanism by which society pursues conservation. We label the conservation level at any given time period, $x_{OA} - x$, as $G(S)$. Note that the cost of resource misallocation, in terms of net marginal benefit to society, should not vary by institution. Thus the NMBC, or the savings or losses from not using the resource in the current period, represent exchange costs from inefficient conservation under any institution. We identify the net *total* conservation costs, $\int_G NMBC$, as the costs of imperfect governance, in terms

of benefits foregone (GBF).¹⁴ Thus, as the net total benefits of conservation increase (shift out), either through increasing demand for resources or reduced conservation costs, optimal governance will also increase, regardless of functional form or institutional structure and without requirement for institutional change.

One can think of two distinct forces acting to make $MGC(S)$, and total governance costs, $GC(S)$, increasing in the level of the resource stock. First are the costs of enforcing against involuntary trades and reducing agency problems of cheating, or the transaction and enforcement costs. These governance costs are expected to be positive and increasing in the stock of the natural resource ($GC(S) > 0$, $MGC(S) > 0$, $MGC'(S) > 0$) as the cost of protecting every unit of the resource will be higher than the cost of protecting a single remaining unit. Accordingly, these costs will vary in the short run within any institution, and may also vary in the long run as institutional structure affects changes in the cost structure. The second group of costs consists of the informational costs of identifying all voluntary trades and reducing agency problems of defection. The cost of identifying trades will be an increasing function of resource abundance, and hence conservation. Additionally, the cost of identifying trades will clearly increase with the level of centralization of decision-making. Fixed costs may also be incurred with respect to enforcing and identifying trades. These costs are “long run” costs that vary by institution but are unlikely to vary considerably with the level of governance within a given institution.

For example, we expect that economies of scale are better captured under hierarchical management or institutions, while economies from specialization of trade are better captured under decentralization of decision-making. These differences indicate that though governance costs are expected to increase under both institutions, they will not do so uniformly. Thus, constitutional agency costs must be considered explicitly when analyzing economic development and growth.

These two types of costs will differ across institutions inasmuch as they differ in the centralization of decision-making and authority. Thus, as we sum them into governance costs within an institutional framework, we acknowledge these distinctions explicitly. In other words, if $G(S)$ delineates the efficient level of governance regardless of institution, where $NMBC(S) = MGC(S)$, then each institution's governance costs, $GC_i(S)$, where i indexes

¹⁴ Note that when GBF=0, Conservation is optimal for the given period.

institutional choices, must be equal to or above the cost of achieving the efficient level for every level of governance, so that the minimum of $GC_i(S)$ delineates the second-best optimal governance level within an institution. The optimal institutional framework is determined by identifying the minimum across institutions, once all systems costs are included. The institutional frameworks that best provide the efficient level of governance, $G(S)$, will vary according to their ability to minimize system costs.

From equation (1.2), assuming that the extraction cost is constant, the optimal condition can be written as:

$$P_t = c + \frac{\dot{P}_t + M\dot{G}C_t}{r - F'(s_t)} + MGC_t$$

Assuming the initial stock of the resource (e.g. virgin forest, uncultivated soil quality, undepleted fish population) is higher than the steady state, the marginal user cost is increasing over time. If the demand function is constant, optimal resource extraction decreases over time, and, since open access extraction is constant for this case, optimal conservation increases.

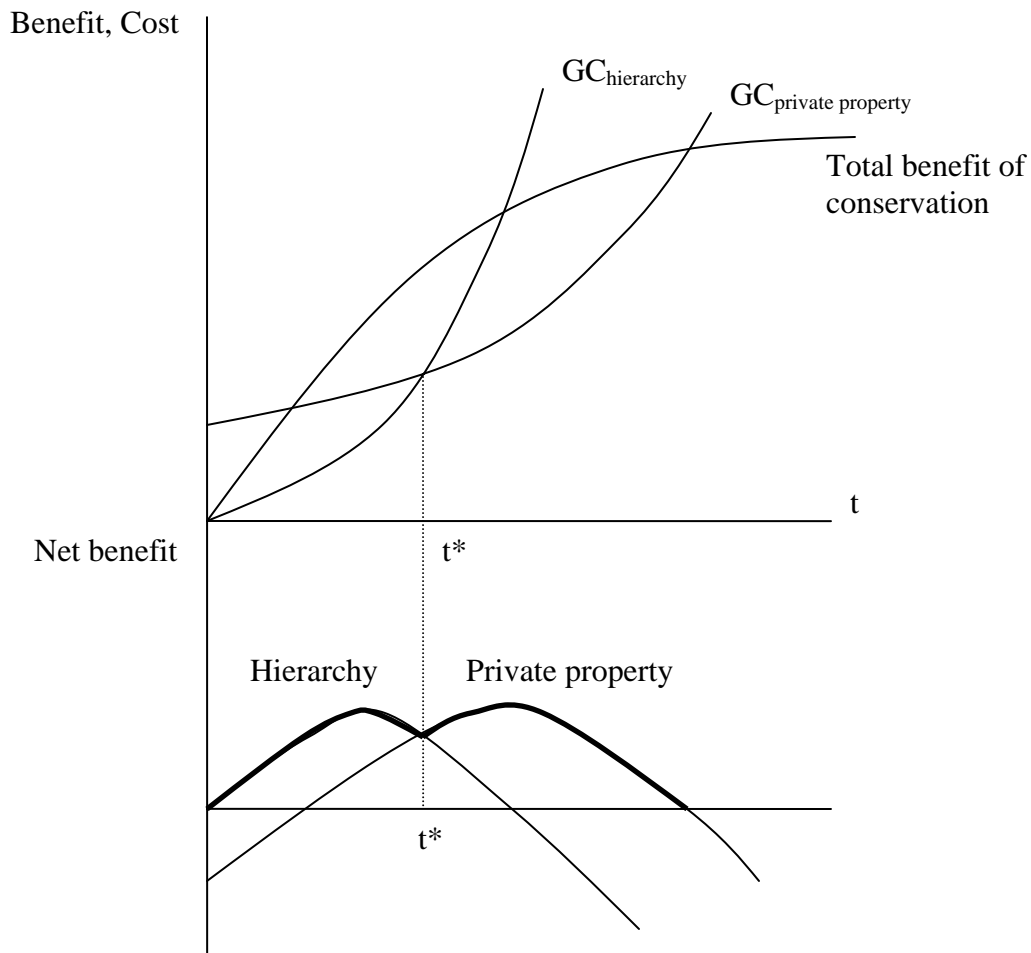


Figure 4. Comparative Institutional Transaction Cost Analysis

The upper panel of figure 4 shows the total benefit and the total cost of conservation over time. As the amount of optimal extraction decreases, the benefit of conservation increases until reaching the steady state. Assume that there are two institutions: hierarchy (no fixed cost, high marginal cost), and private property (fixed cost, low marginal cost). At $t=0$, where the conservation level is low, the governance cost of the hierarchy system is lower than that of the private property system. As the optimal conservation increases over time, the governance cost of the private property system become less expensive (at t^*).

The lower panel shows the net benefit of the conservation. From time 0 to t^* , the hierarchy system will be employed as it creates higher net benefits. However, as the conservation level increases, the advantage of the hierarchy system decreases. After time t^* , the private property system becomes more efficient.

4. Application to the Hawaii Case

4.1. Growth and institutional change

We hypothesize that had Hawaii maintained independence as a kingdom longer after western contact rather than becoming part of the United States in the late 1890s, the centralization of authority and decisions would have been unstable and failed to last (Glaeser & Shleifer, 2003). Of the many Pacific Island kingdoms that developed via similar hierarchical processes to Hawaii, only Tonga remains a monarchy today. The Tongan monarchy is increasingly unstable, as population pressures that challenge longstanding mandates of land tenure¹⁵ make it difficult to resist calls for democratic reform and devolution of power; its first democratically elected prime minister took office in 2006.

According to the theory set forth above, efficient governance becomes more centralized as an economy grows, while efficient decision-making becomes first more centralized then more decentralized. An alternative path, where decision-making also continues to become more centralized, is not expected to be optimal as the constitutional agency costs shift to favor a system that minimizes governance costs at a higher governance level, capable of sustaining higher resource pressures. Furthermore, within every institutional framework, governance efforts increase in response to benefits of greater specialization, intensification and greater resource scarcity. The Hawaiian record is consistent with this perspective.

Extensive growth, characterized by consistently replicated patterns of use, results in constant returns to inputs of labor and capital as long as the underlying resource base is constant. Extensive growth requires little governance or enforcement. As such, decision structures may be fairly flat and authority rather decentralized. In Hawaii, this is clearly the case in the

¹⁵ Each male at age 16 is to receive 8.25 acres [U.S. Department of State Background Note, Tonga, 2003]

colonization and development eras; as *ohana* networks provide both the decision-making and the authority at the level of the extended family, or tribe.

Once the best land is brought under cultivation, production expands according to the increasingly intensive Ricardian gradient. As returns diminish, specialization and intensification may evolve to increase yields from an existing resource base through land-saving technical change. The use of labor-saving tools begins along with modest capital accumulation. Intensive growth is further promoted by specialization, as witnessed by standardization of production tools and techniques. Increasingly centralized decision-making facilitates horizontal specialization by task. Vertical specialization increases. The chiefs and *Ali*'s are not replaced; they are merely consolidated by adding vertical layers. Governance expenditures increase accordingly as warranted by the gains from *horizontal specialization*. In the case of Hawaii, as population grew and spread from the coast inland, intensification generated stronger links between *ohana* and the hierarchical authority and decision-making increased together, taking advantage of increasing specialization in agricultural and fisheries inputs and outputs.

Evidence from joint archaeological and soil scientist work (Vitousek et al, 2004; Kirch et al, 2004) on the intensification of dryland agriculture on Maui and Hawaii versus the less labor-intensive, higher-surplus irrigated wetland agriculture on Kauai and Oahu may explain why the more aggressive and expansive chiefdoms grew from Maui and Hawaii, and that final unification came under a chief from Hawaii, rather than the older islands of the archipelago. These chiefs were motivated to increase their authority and expand their territory because the rents they could extract from the marginal lands they controlled were lower than those extracted by the chiefs irrigated wetlands.

As demand increases, whether due to increased population pressure or increased opportunities for rent-seeking, resource productivity may be enhanced through capitalization that captures economies of scale. Infrastructure and other capital-deepening enterprises may increase the productivity of existing resources (e.g. the effect of irrigation on land and water productivity) and/or increase resource flows from existing stocks. Increasingly centralized authority and decision-making will together increase the ability to capture economies of scale. As the hierarchical authority in Hawaii strengthened, large capital projects, particularly fishpond

construction to enhance fish stocks and irrigation projects to increase taro production, were undertaken, with rents accumulating mainly to the high chiefs.¹⁶

Though the big picture of institutional change in Hawaii is one of increasing resource pressure accompanied by increasing governance and decentralization of authority, governance may also vary over space and time according to the present value of the remaining resource stock. For example, when costs of maintaining property rights increased for the *konohiki* fisheries at the end of the 19th century, responses varied according to economic benefits of the resource, with higher-valued fisheries commanding greater effort in the establishment of rights. Furthermore, as time decreased the value of all coastal fisheries due to native population reduction, increasing international trade and the greater availability of preferred substitutes, governance over all coastal fisheries decreased.¹⁷

Throughout the process of consolidation, the responsibilities of the commoners changed little; each was expected to perform his farming or fishing duties under the authority of the *ahupua'a konohiki*. Two important trends evolved, however. First, the commoners developed specialized skills (e.g. in taro and dryland farming and various fishing techniques), enhancing resource productivity while tying them more closely to the *ahupua'a* (Handy and Handy, 1991, p. 310ff). Second, the *konohiki's* role of manager evolved with increased responsibilities and specialized knowledge (e.g. organizing hukilau, irrigation and other communal activities). When the position of *konohiki* first emerged (during the expansion period), he was primarily a tax collector providing service for a superior *ali'i* in return for status and a portion of the harvests. By the time of the Great *Mahele*, his role had been gradually transformed into a position that claimed ownership of the resources, and the associated ability to make decisions. This presented the attractive option to separate authority and decision-making in the move to private property by

¹⁶ From records of oral genealogical history, we know that populations must have been driven to create ponds as soon as there was sufficient labor available to do so, if appropriate environmental conditions existed. There are at least 6 fishponds constructed on Oahu and Kauai before the 13th Century (Kikuchi, 1973). Also at this time communities begin to develop in the drier, leeward valleys, suggesting population expansion and resource pressures. The primary growth in fishponds is attributed to the 16th Century (Kikuchi, 1973), as is the growth in population. By the 18th Century, repairs to existing ponds may have been as important as new construction. The last ponds were constructed at the beginning of the 19th Century, as Western contact and the resulting population decreases changed the social structure and manpower of the islands. There were also more profitable opportunities for the *ali'i* developing in trade for other resources, particularly sandalwood.

¹⁷ See Appendix 3 in Kaiser and Roumasset 2007 for supporting discussion

leaving the management of low-value coastal resources to the *konohiki*, lowering governance costs of the new system.

5. Conclusions

We provide a dynamic theory of property rights focused on the co-evolution of governance, specialization, intensification, and economic growth. In particular, we elucidate the dynamic foundations needed for a complete theory of second-best resource management. We have also sketched a categorical theory explaining why, as the benefits of resource management increase with population pressure or other causes of specialization, governance costs increase both within and across institutions. A methodological point of possible interest is that second-best analysis cannot proceed without first-best analysis. Indeed this is implicit in Coasean analysis. It is precisely the proposition that, absent transaction costs, different institutions are capable of the same first-best solution, which allows us to use the first-best solution as a benchmark against which the transaction costs of alternative institutions can be compared.¹⁸

More specifically, with respect to alternative solutions to the open access problem, we have shown the following. First, it is not necessarily a problem; open access can be the first-best solution. This is the case in early Hawaiian history, when resource pressures were low, and though the *kapu* institution was available as it was brought with the first settlers, its use was expectedly minimal. Second, even if open access is first-best inefficient, it is not necessarily the case that open access is inferior to at least one of the three proposed alternatives; it can be second-best efficient. Indeed, we have suggested that there is a second-best transition, as the optimal degree of specialization increases, from open access to common property management to private property, which helps to explain the *governmental Kuznets curve*.

The second-best theory of induced institutional change predicts an increase in conservation effort as population pressure and modernization deplete natural resources. Unlike previous theoretical frameworks, the suggested theory allows for changing resource extraction (or changing investment) over time. We witness this increase in conservation effort in Hawaii along with institutional development that benefits from the ability of hierarchy to capture economies of scale in land and resource management, and then seeks to benefit from the change

¹⁸ For this to be generally true, we must use transaction costs in its broadest sense, i.e. that transaction costs are the costs of running the economic system and are the equivalent of friction in physical systems (Williamson, 1985).

in relative benefits by decentralizing decision-making into the hands of the *konohiki* rather than the king. The increase in governance and the institutional change from open access to the intermediate *ahupua'a* system and later to a centralized system accord with second-best theory. Religion and brutal hierarchical control were used effectively to enforce limited access at relatively low cost.

While the co-evolution of intensification, specialization, and consolidation are consistent with second-best theory, subsequent developments require third-best analysis. For example, while centralized governance was initially effective at resource conservation (under King Kamehameha I), the inherent opportunities for rent-seeking were exploited by King Kamehameha II (Liholiho) and subsequent rulers. The intervention of Western culture and politics created an additional third-best force at odds with efficient institutional change. Western influence stressed the hierarchical system in at least two ways. First, it provided opportunities for specialization and trade beyond *ahupua'a* boundaries that were not readily captured under *ahupua'a* governance. Second, Western contact increased the benefits of extracting labor taxes from the commoners in order to import status goods.

From Hawaiian history, we garner three potential trends in institutional evolution. First, each institutional framework has some flexibility in accommodating increased governance. Governance within an institutional system can respond to changes in resource pressures, albeit large changes in relative prices may occasion a transition to new institutions. Subsequently, we see continued evidence of the ways in which resource use intensifies and develops, creating economic growth, even with population decline rather than growth. Finally, institutions do not simply switch instantaneously from one form to another, even when they are seemingly imposed. The example of the *konohiki's* slow transition from a minion of the *ali'i*, to an incentive-driven resource owner, shows the shift from manager to owner that accompanies a shift from a common property regime to a private property one.

As Hawaii's population increased, production systems were intensified. Social organization became increasingly complex, accommodating increasing division of labor. The increased vertical and horizontal specialization was facilitated by new incentive and governance structures summarized by the *governmental Kuznets curve*. Specifically, we witness a natural progression from a small, ohana network of reciprocal exchange, managed by a clan chief, to an

increasingly stratified hierarchy and resulting in a monarchy in 1805. With Western contact, relative resource values diverge greatly from the past, and a new path toward decentralization of decision-making begins while centralization of authority is transferred from one institutional framework to another but continues to intensify, despite the decline of population. With respect to marine property, this increasingly centralized authority is evidenced in the increasing adoption of open-access fishing restrictions. At the same time the government foregoes its previous rights to shares of the catch, which are dwindling in economic importance.

We see increased governance and development of hierarchy as populations grow. In addition, it follows that the value of marginal land, as the land is being cleared with population growth and added to the resource base, satisfies the condition that the cost of clearing equals the present value of implicit rents that it earns in the future. In this case, the marginal user cost of land as capital is constant until the land frontier is reached and intensification begins. With even greater population pressure, intensification and resource depletion, however, potential gains from trade across districts increase (LaCroix and Roumasset, 1984) and the dictatorial hierarchies controlling each ahupua'a economy were not well suited to exploit those opportunities. If such potential gains are large enough to warrant the increased governance costs of further centralization of authority (albeit not necessarily of decision-making), the second-best theory predicts that such institutional change will take place. At the time of Western contact, Hawaii was headed for just this sort of unification of authority.

Inasmuch as Western institutions were exogenously imposed, we cannot be sure that hierarchical authority would have eventually withered away and been replaced by market institutions. Considerable specialization and exchange was possible within the hierarchical system. The development of the position of *konohiki* as a specialized land manager and then its transformation into resource owner exemplifies the interdependence of specialized skills and productivity, which intensifies along with institutional change.

To the extent that inter-district trade is facilitated by centralized authority and decentralized decisions, two questions arise that may be suitable for further research. First, can the decentralization of decision-making evolve from the top-down system of medieval Europe or pre-contact Hawaii without violence or external force? Second, where decision-making is centralized as well as authority, e.g. as in socialism, is it prudent to transition directly to

decentralized exchange at the national level or is devolving central authority to a sub-national level a useful intermediate step?

We hope that the theory provided here is found to be applicable elsewhere. While we have emphasized the role of efficiency in determining the co-evolution of production and governance, extended models will have a less deterministic flavor. In particular, the balance of rent-seeking and efficiency will vary according to specific circumstances. While replacement of the Hawaiian monarchy by private property was accelerated by coincidence, other economies may exhibit more institutional inertia. Shocks to population (e.g. from disease), changing international demands and the transaction costs of trade, and shocks to the resource base itself, e.g. via invasive species, are natural candidates to explore in numerical analysis.

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